THE ALASKA BROADBAND EDUCATION GAP

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In Alaska where a significant number of schools are located off the road system in rural and remote areas, broadband connectivity is essential to the education of the state's students. As more and more districts are participating in 1:1 initiatives and engaging in distance learning, connectivity challenges are hindering educational successes like never before. Across the state, a number of challenges create a broadband education gap among the state's high poverty areas, those with significant Native American populations, and those located in rural and remote villages. Slow broadband speeds that fail to meet national benchmarks, high costs for services in remote areas, poor quality Wi-Fi, inadequate latency, and underutilized WAN potential are just a few of the issues that Alaska schools face daily.

To analyze these issues fully and explore how they are contributing to an education gap, this Report first looks at the state as a whole and its connectivity compared to national benchmarks, and then compares the various regions of the state to pinpoint areas of particular need.

National Benchmarks and Key Statewide Findings

The goal of the Alaska School Broadband Audit was to assess and identify gaps in the availability, quality and use of broadband and broadband-enabled technology at Alaska's K-12 public schools, to determine the progress that the Alaska K-12 education system is making with regard to advanced, digital, and distance learning. As discussed elsewhere in this Report, digital learning and broadband technology can give Alaskan students, particularly those in rural areas, access to a world of learning opportunities. In addition, distance learning and broadband can offer significant savings in educating Alaskan youth, allowing smaller, more rural districts to share resources and curricula, offer an increased variety in educational opportunities, and potentially lower the cost of classroom instruction overall.

To undertake this analysis, Connect Alaska **collected** and **validated** the adoption, quality, and use of broadband service and broadband-enabled technology at Alaska's K-12 public schools, including information from 53 districts in the state. Connect Alaska network engineers collected and validated dozens of pieces of individual data, working directly with school administrators, teachers, and IT staff to ensure that the Audit dataset is the most comprehensive and accurate collection of K-12 school broadband and technology data ever collected. As discussed below, all of this data is available through the Connect Alaska School Broadband Audit website, for the public and policymakers to access and compare individual school and district information. The dataset also allows for considerable analysis of trends both on a state and regional basis.

The Audit data reveal that there are **substantial gaps** in the availability, adoption, and use of broadband and broadband-enabled technology in Alaska, and that Alaska K-12 students risk falling behind national benchmarks that have been set for school and district Internet connectivity.

I. 93% of Audited Alaska K-12 schools do not meet the national benchmark of 1000 Kbps per student and staff.

The "connected school" is a sophisticated environment for information technology and broadband usage. In a relatively confined space such as a classroom or school wing, dozens of students and teachers frequently and simultaneously use a myriad of devices and online applications and services, all of which need to be independent of one another and have sufficient capacity. Compared to a typical American household, which has on average only 7 Internet-connected devices,[1] the Internet needs of school buildings and classrooms are substantially greater.

To address these needs, in 2015, the FCC established Internet connectivity benchmarks for K-12 schools that are based upon the amount of Internet capacity for each student and staff.[2]

Table 1: K-12 School Internet Capacity Benchmarks

Short Term	Long Term (by 2020)
100 Mbps for each 1000 student and staff/ 100 Kbps for each student and staff	1 Gbps for each 1000 student and staff/ 1000 Kbps for each student and staff

The FCC established these national benchmarks to assist in managing the nation's largest educational technology funding program, the E-rate program. As discussed below, the FCC has implemented a number of programs inside the E-rate program designed to assist school districts in meeting these speed benchmarks. Indeed, certain programs designed to help fund network construction are limited only to fund projects that will meet the long-term connectivity goal.

As evidenced in the Audit, Alaska schools are not on pace to meet either of these national benchmarks. Forty-two percent (42%) of audited schools (198 of 471) have connectivity of less than 100 Kbps for each student and staff, which is the FCC's near-term goal for school broadband connectivity accounting for 63,724 underserved students.

Ninety-three percent (93%) of the schools audited (439 of 471) do not have connectivity at 1000 Kbps for each student and staff. On average, K-12 schools in Alaska have 246 Kbps of connectivity for each student and staff. This is well shy of the FCC and SETDA benchmark of 1000 Kbps for each student and staff member.

Below, Table 2 shows that schools not meeting the nationwide benchmarks are located in all areas of the state, in urban and rural areas, and in areas with different poverty rates. Failure to meet these standards is seen in all regions across Alaska, as Figure 1 shows.

[1] Federal Communications Commission, *2015 Broadband Progress Report*, GN Docket No. 14-126, FCC 15-10 (rel. Feb. 4, 2015), available at: http://www.verizon.com/cs/groups/public/documents/adacct/bandwith-and-multipledevice.pdf, at para. 29.

[2] Federal Communications Commission, *Modernizing the E-rate Program for Schools and Libraries,* WC Docket No. 13-184, Order and Further Notice of Proposed Rulemaking, 29 FCC Rcd 8870 (2014) (*First E-rate Modernization Order*), available at: https://apps.fcc.gov/edocs_public/attachmatch/FCC-14-99A1.pdf, at paras. 34-38.

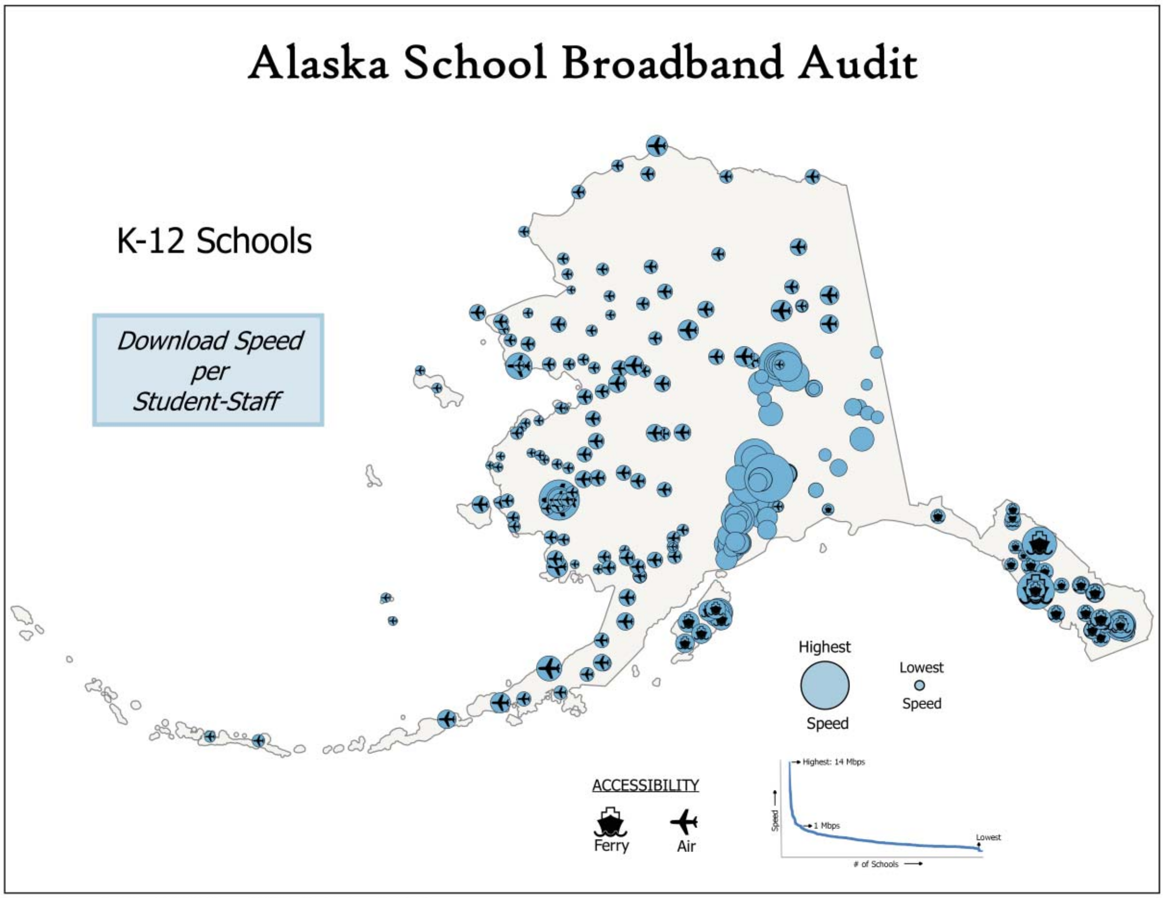
Table 2: Regional Benchmark Analysis

Regions	Total Audited Schools With Reported Connectivity	Number of Schools With Connectivity of <100 Kbps/ Student-Staff	Number of Schools With Connectivity of <1000 Kbps/ Student-Staff	Average Connectivity/ Student-Staff (Kbps)
Statewide	**471**	**198**	**439**	**246**
Rural[3]	333	129	310	301
Urban	138	69	129	201
Central	263	95	241	265
Northern	57	34	57	52
Southeastern	60	13	54	383
Southwestern	35	22	34	55
Western	56	34	53	115
Air	159	95	155	79
Ferry	75	15	65	466
Road System	237	88	219	249
Northern, air only access; satellite as primary network access	57	34	57	52
Road-based access and fiber access; large student population in large sites	232	88	213	255
Road system; fiber access, medium to small schools	18	8	18	117
Southeast, ferry as primary access; microwave or fiber access in most	62	7	53	549
Southwestern Rural remote, air access only; generally small sites with primarily satellite and some microwave	35	22	34	55
Western, air only access and either satellite or microwave; large student population primarily spread over many small sites	67	39	64	112

[3] This analysis utilizes definitions of "rural" and "urban" schools and districts adopted by the FCC in December 2014 for use in the E-rate program, as the E-rate program provides a substantial share of funding for broadband connectivity for Alaska K-12 schools and libraries. Those new FCC rules regard the Anchorage, Fairbanks, and Matanuska-Susitna school districts as "urban" and all other school districts in Alaska as "rural." The FCC E-rate program regards a school as being "urban" if it is located in an area regarded by the U.S. Census Bureau as an "Urbanized Area" or an "Urban Cluster" with a population of 25,000 or more. A school is regarded as being "rural" if it is not regarded as "urban." To determine whether a particular school district is "urban" or "rural" is based on whether the majority of schools in that district fall into either the "urban" or "rural" category. Because school district boundaries do not necessarily follow U.S. Census Bureau geographies, an "urban" district may have "rural" schools. For example, in the Anchorage school district, 11 schools are located in "rural" areas.

School districts with largest share of White students	306	104	278	278
School districts with largest share of American Indian or Alaska Native students	163	92	159	86
Poverty rate of 10% or less	245	97	226	252
Poverty rate between 10% and 21%	100	30	89	386
Poverty rate between 21% and 30%	90	44	88	105
Poverty rate of 30% or more	36	27	36	43

Figure 1: Map Highlighting Regional Benchmark Analysis



II. The Alaska School Broadband Assistance Grant program appropriately targeted schools that did not meet broadband capacity benchmarks; however, those grants were temporary and these recipient districts are now at risk of backsliding.

In 2014, the Alaska State Legislature created the School Broadband Assistance Grant program (School BAG). The program is administered by the Alaska State Library and assists schools in reaching Internet download speeds of 10 Mbps from February through June 2015. School districts that have less than 10 Mbps download speeds could apply for School BAG funds; the Alaska State Library awarded nearly $5 million in funds in February 2015 to 27 school districts. The School BAG grants are offered to assist districts in paying for their portion of Internet connectivity through the FCC's E-rate program.[4] The Legislature made $5 million available for Fiscal Year 2015 for connectivity through June 2015 only, and as of this writing, funding for the program has not been renewed for Fiscal Year 2016.

At the time Connect Alaska began to collect Alaska School Broadband Audit data, the School BAG grants had not been awarded, and connectivity generally had not been upgraded at recipient school districts. The Audit data does show that the School BAG grants were targeted to school districts that had the most need for broadband Internet connectivity. However, even with these grants that would bring school connections up to 10 Mbps for five months, connectivity for many schools in the targeted districts would still falls short of nationwide connectivity benchmarks.

[4] For a discussion of the E-rate program and Alaska, see the E-Rate and Alaska Education section of this report.

Twenty-seven Alaska school districts received School BAG grants in 2015, for a total of $4.909 million.

Table 3: School BAG Grants by School District

School District	FY 2015 School BAG Grants
Alaska Gateway	$236,548.20
Aleutians East	$164,383.24
Aleutian Region	$217,907.69
Bering Strait	$553,482.92
Bristol Bay	$85,503.02
Chatham	$73,073.28
Chugach	$292,457.76
Dillingham City	$149,903.27
Hoonah City	$18,414.40
Iditarod Area	$209,840.84
Kashunamiut	$33,232.71
Kenai Peninsula	$21,687.07
Kuspuk	$151,920.97
Lake and Peninsula Borough	$358,992.42
North Slope Borough	$255,520.00
Northwest Arctic Borough	$480,014.89
Pelican City*	$40,155.40
Pribilof	$19,991.06
Saint Mary's	$66,089.58
Southeast Island	$392,114.36
Southwest Region	$564,631.70
Tanana City	$79,224.41
Unalaska City	$46,327.98
Yakutat	$24,718.81
Yukon Flats	$183,966.80
Yukon-Koyukuk	$127,392.07
Yupiit	$102,327.08

Source: Alaska State Library.
*Pelican City was unable to make the network upgrade and returned these grant funds in Fiscal Year 2015.

In general, School BAG grants went to the most severely challenged districts in the state, including those with severe connectivity gaps and vulnerable populations. Of the $4.9 million awarded, 69% went to districts in which the average Kbps per student and staff was below the 100 Kbps near-term FCC benchmark.

Case Study 1: St. Paul School, Pribilof School District

St. Paul School is located on the remote Pribilof Island group on Saint Paul Island in the Bering Sea. The school is a single structure that educates students in Kindergarten through Grade 12 with the district office on site as well. The district is working to implement 1:1 initiatives and currently exceeds the state average in device availability in the classroom. However, the ability to realize the full potential of this digital transition has been severely limited by the insufficient network in the classroom.

While the district currently possesses a sufficient LAN, the WAN has previously been connected to the Internet with satellite at a speed of only 1.5 Mbps. The speed gap substantially limited what the district was able to implement for curriculum and required the on-site location of many services that would be better served to the school if bandwidth allowed cloud services to be used. As part of the School BAG program, St. Paul School has had that capacity expanded to 10 Mbps – but this increased speed is only available until the end of June. Assuming there will be no funding for additional bandwidth from the state beyond that date, the Pribilof Island School District is planning to drop back to 4 Mbps, with 2.5 Mbps being dedicated to St. Paul School.

With a small student population of 82 district-wide, sustained robust speeds would allow for services that could be accessed off-site and would offer many more options for extended learning.

The vast majority of funding – $3.6 million – went to districts that serve predominantly Native American student populations. Schools generally off the road system and in communities with high poverty rates also received most of the School BAG funding.

Table 4: School BAG Funding and Student and Staff Population

	Total School BAG Funding	Total Number of Students and Staff
Statewide	**$4,909,666.53**	**139,029**
Central	$760,533.87	104,423
Southwestern	$1,607,640.38	9,806
Southeastern	$508,320.85	12,565
Northern	$1,679,601.09	2,660
Western	$353,570.34	9,575
School Districts with average connectively <100 Kbps/Student-Staff	$3,372,188.55	69,986
School Districts with average connectively >=100 Kbps/Student-Staff	$1,537,477.98	67,941
Rural	$4,909,666.53	51,542
Urban	-	87,487
Air	$4,143,110.41	22,687
Ferry	$508,320.85	15,819
Road System	$258,235.27	100,523
School districts with poverty rate of 10% or less	$178,236.88	105,577
School districts with poverty rate between 10% and 21%	$1,673,169.49	15,927
School districts with poverty rate between 21% and 30%	$2,185,250.65	11,912
School districts with poverty rate of 30% or more	$873,009.51	5,613
School districts with Largest share of Caucasian students	$1,062,208.65	115,824
School districts with Largest share of American Indian or Alaska Native students	$3,629,550.19	23,164

Were School BAG funding still available and made permanent, the number of Alaska schools that would meet the FCC's near-term goal for school connectivity of 100 Kbps for each student and staff member would increase substantially. Because many of the schools in grantee districts serve small student body populations, even a connection of 10 Mbps can have a dramatic impact. Table 5 below outlines the impact that upgrading schools in the grantee districts to a minimum of 10 Mbps would have on Alaska's progress toward meeting this goal.

Table 5: Impact of BAG Funding on Increase Connectivity

School District	Total Number of Schools in District	Number of Schools with Connectivity ≥100 Kbps/Student-Staff		
		Before BAG Funding	After BAG Funding	Difference
Alaska Gateway School District	8	4	7	3
Aleutian Region School District	2	0	2	2
Aleutians East Borough School District	5	4	4	0
Anchorage School District	97	19	19	0
Annette Island School District	4	4	4	0
Bering Strait School District	15	4	8	4
Bristol Bay Borough School District	3	0	2	2
Chatham School District	5	3	3	0
Chugach School District	4	0	2	2
Copper River School District	5	2	2	0
Cordova City School District	3	0	0	0
Craig City School District	4	3	3	0
Delta Greely School District	6	2	2	0
Denali Borough School District	4	3	3	0
Dillingham City School District	3	0	0	0
Fairbanks North Star Borough School District	35	34	34	0
Galena City School District	4	0	0	0
Haines Borough School District	3	1	1	0
Hoonah City School District	2	0	0	0
Hydaburg City School District	2	1	1	0
Iditarod Area School District	8	6	7	1
Juneau Borough School District	14	5	5	0
Kake City School District	1	1	1	0
Kashunamiut School District	1	0	0	0
Kenai Peninsula Borough School District	43	40	40	0
Ketchikan Gateway Borough School District	10	9	9	0
Klawock City School District	1	0	0	0
Kodiak Island Borough School District	14	13	13	0
Kuspuk School District	9	7	8	1
Lake and Peninsula Borough School District	14	7	13	6
Lower Kuskokwim School District	28	13	13	0
Lower Yukon School District	10	0	0	0

Matanuska-Susitna Borough School District	45	43	43	0
Nenana City School District	2	0	0	0
Nome Public Schools	5	2	2	0
North Slope Borough School District	11	3	3	0
Northwest Arctic Borough School District	13	2	4	2
Pelican City School District	1	0	0	0
Petersburg City School District	3	3	3	0
Pribilof Island School District	2	0	2	2
Saint Mary's School District	1	0	0	0
Sitka School District	6	5	5	0
Skagway School District	1	0	0	0
Southeast Island School District	10	8	8	0
Southwest Region School District	7	2	4	2
Tanana City School District	1	1	1	0
Unalaska City School District	2	0	0	0
Valdez City Schools	4	2	2	0
Wrangell Public School District	3	3	3	0
Yakutat School District	2	1	1	0
Yukon Flats School District	7	5	5	0
Yukon-Koyukuk School District	10	8	9	1
Yupiit School District	3	0	0	0
Statewide	**506**	**273**	**301**	**28**

Had the School BAG grants been permanent, the percentage of Alaska public schools that would meet the near-term connectivity goal of 100 Kbps for every student and staff member would at least increase by 6%, to 64% of Alaska K-12 schools. The upgrades in districts receiving School BAG grant funds would have brought most of the schools in those districts up to and beyond the near-term connectivity goal of 100 Kbps/student and staff. In addition, if School BAG funding were permanent, Connect Alaska estimates that the $5 million invested in School BAG connectivity grants would create **$39.7 million in additional funds from the federal E-rate program.** This surge would **more than double** the amount of E-rate funds that Connect Alaska estimates that Alaska schools received for their broadband connections in 2014. However, this progress and these benefits are at risk, because these upgrades were only funded for five months.

As of this writing, the School BAG program has not been funded beyond June 2015. As a result, school districts are now facing difficult decisions as to whether they can afford to keep this upgraded connectivity, or be forced to lower bandwidth. Connect Alaska field teams have heard of schools that will, out of financial necessity, be ramping down broadband capacity in the coming school year because of this funding shortfall. While the School BAG program held great promise for closing at least the near-term connectivity gap for many Alaska schools, that progress was fleeting.

III. K12 schools have the lowest connectivity of Alaska Public Schools.

In many remote parts of the state, numerous schools comprehensively serve students Kindergarten through Grade 12 and act as a crucial part of the Alaskan public education system. In the Audit dataset, there are 196 of these K12 schools serving 22,284 students. These schools are frequently small, are often off the road system, and must serve a wide and diverse array of students, ranging in age from 5 to 18.

As can be expected, K12 schools have to offer a wide array of curricula to their students, and faculty need to be expert and conversant in a number of subjects. As a result, students and educators in these K12 institutions in Alaska likely have the most to gain from broadband technology and digital learning, as this technology holds the promise of opening up a broad array of educational materials and wider connections to teachers and student peers.

However, as a group, **Alaska K12 schools are the most disconnected in the state**. In terms of Internet access capacity available to students and staff, K12 schools have significantly lower broadband connectivity than dedicated elementary, middle, and high schools. The average K12 school in Alaska has connectivity of 118 Kbps per student and staff, well below the statewide average of 246 Kbps for each student and staff.

In addition, the cost of providing this broadband to K12 schools in the state is substantially more costly than other schools – over $110 per month for every student and staff member, compared to $30 per month statewide.

Case Study 2: Whittier Community School, Chugach School District

Whittier is a very beautiful, yet remote, town located on Prince William Sound just 60 miles southeast of Anchorage. Because of its prime location more than 700,000 tourists and visitors come each year. Whittier Community School educates the community's 35 students of all grades, from pre-K through Grade 12. Connect Alaska engineers observed first-hand that broadband access is a challenge for this destination community. However, the costs of increasing bandwidth to 20 Mbps, including covering the network management and improvements needed, are estimated to be $50,000. For the small school, these costs are prohibitive and network upgrades cannot be made at this time. Increasing connectivity in the school would greatly impact student learning and no doubt have a ripple effect on the community's efforts to remain a tourist destination and gateway.

Table 6: Connectivity and Technology by School Type

School Type	Connectivity (Kbps/Student-Staff)	Devices/Student	Broadband Monthly Cost/Student-Staff	Broadband Monthly Cost/Mbps
K12 schools	118	0.81	111	943
Elementary	257	0.51	12	46
Middle or High schools	291	0.58	13	46
Statewide	**246**	**0.59**	**30**	**122**

Without a doubt, this level of broadband service at K12 schools in Alaska is related to their generally rural and remote nature as well as their small size. Telecommunications networks have high fixed costs and substantial economies of both scale and density, which mean that purchasing relatively low levels of bandwidth to serve a smaller population will result in higher per-megabit and per-student costs. As a result, relatively remote and smaller K12 institutions are less likely to benefit from the economies of scale and density that are characteristic of broadband connectivity. That said, as discussed below, another finding of the audit is that rural and off-road schools in Alaska tend to have **greater** connectivity on a per-student and staff basis than their urban counterparts despite these higher costs. This finding indicates that demand for broadband in education in rural and off-road settings is strong, in spite of the substantial cost challenge. However, broadband to K12 institutions statewide as a group lags substantially. Recognizing the significant broadband gap these schools face is important as the broadband gap is likely to hinder educational opportunities for Alaska students attending K12 schools.

IV. Schools with high poverty rates have lower connectivity and pay more for the connectivity they receive.

Even when compared to peers in their district and region, schools located in communities with high poverty rates are substantially less connected than schools in lower-poverty communities.

Table 7: Speed and Cost by School Classification/Poverty Rate

School Urban/Rural Classification Under E-rate Rule	Poverty Rate	Kbps/Student-Staff	Total Monthly Cost/Student-Staff	Total Monthly Cost/Mbps
Rural	Poverty rate of 10% or less	369	$12	$32
	Poverty rate between 10% and 21%	386	$69	$180
	Poverty rate between 21% and 30%	115	$121	$1057
	Poverty rate of 30% or more	43	$163	$3790
Urban	Poverty rate of 10% or less	204	$6	$30
	Poverty rate between 21% and 30%	24	$13	$550
Statewide	Poverty rate of 10% or less	252	$8	$31
	Poverty rate between 10% and 21%	386	$69	$180
	Poverty rate between 21% and 30%	105	$110	$1044
	Poverty rate of 30% or more	43	$163	$3790

Table 7 shows that statewide, schools in communities with a poverty rate of 30% or above – schools serving nearly 4,900 students – have an average connectivity of **only 43 Kbps per student and staff**, about one-sixth of the statewide average of 246 Kbps/student and staff. Schools with poverty rates between 21% and 30%, serving another 10,000 students, have connectivity of **105 Kbps/student and staff**.

Just as importantly, on a price per megabit basis, these schools are paying more for their service. Schools in communities with more than 30% poverty pay on average over $3,790 per megabit per month, compared to only $31 per megabit per month in areas with poverty below 10%.

While some variation in service quality and cost can be expected based on regional differences Table 7 shows that this relationship between lower speeds and higher costs in high poverty areas is true when only rural schools are analyzed. Low-poverty rate rural schools have more robust connectivity (369 Kbps/student and staff) and pay less on a per-megabit per month basis ($32 per megabit per month) than high-poverty schools in similar rural and remote areas.

V. Technology options and latency impede broadband and digital learning in many parts of the state.

The quality of broadband service is not only related to the raw capacity (speed) of the connection, but also the latency of that communication channel. **Latency** is the time it takes for a broadband communication to travel round-trip from a point in the school to servers on the Internet (which can be located around the world) and back again. Generally speaking, satellite broadband services, which require communication to reach a satellite over 22,000 miles high, have higher latency than land-based systems. A connection with high latency will impede applications that involve real-time interactivity, such as some online testing, distance learning, and two-way voice and video communications.

Because of the remote and inaccessible nature of much of Alaska, many schools depend on satellite service for ultimate Internet connectivity. As Table 8 shows below, 24% of K-12 public schools in Alaska depend on satellite technology to connect to the Internet.

Table 8: Technology Adoption Among Schools and Students

Technology	Number of Schools	Number of Students
Fiber Optic	149 (31%)	49,922
Other Wireline (DSL, cable)	152 (32%)	56,543
Wireless (fixed, mobile, microwave)	53 (11%)	7,871
Satellite	116 (24%)	9,725
Other	9 (2%)	1,151
Total	**479**	**125,212**

As explored in the regional discussions below, there are significant differences in technology choices based on regions.

A school may indeed have a strong, robust physical connection to other local schools or institutions in a remote community, but that community itself might be served through a satellite connection. This satellite connection will impact the effectiveness of digital learning in those classrooms.

As part of the Audit and site visits, Connect Alaska engineers conducted speed tests at school locations to test the quality and latency of this connection. Also, as part of the data collection effort, school administrators and IT staff were given access to a speed test tool. In general, latency information was obtained for a vast majority of districts in Alaska. These test results are broken into three categories:

- Round Trip Latency Less than 100 milliseconds (ms), which is sufficient to support robust digital learning, online testing, and two-way voice and video distance learning;
- Round Trip Latency between 100 ms and 300 ms, which is sufficient to support some digital learning applications and online testing, but will adversely impact two-way voice and video distance learning ; and
- Round Trip Latency over 300 ms, which will generally be insufficient to support many digital learning applications and online testing needs, and which present a substantial barrier to robust two-way voice and video distance learning.

Sorting Audit school speed test results into groupings based on these categories of latency shows that schools educating the majority of Alaska K-12 students have round-trip latency of 100 ms or better, but that there are significant differences in the quality of the online educational experience for many students due to latency.

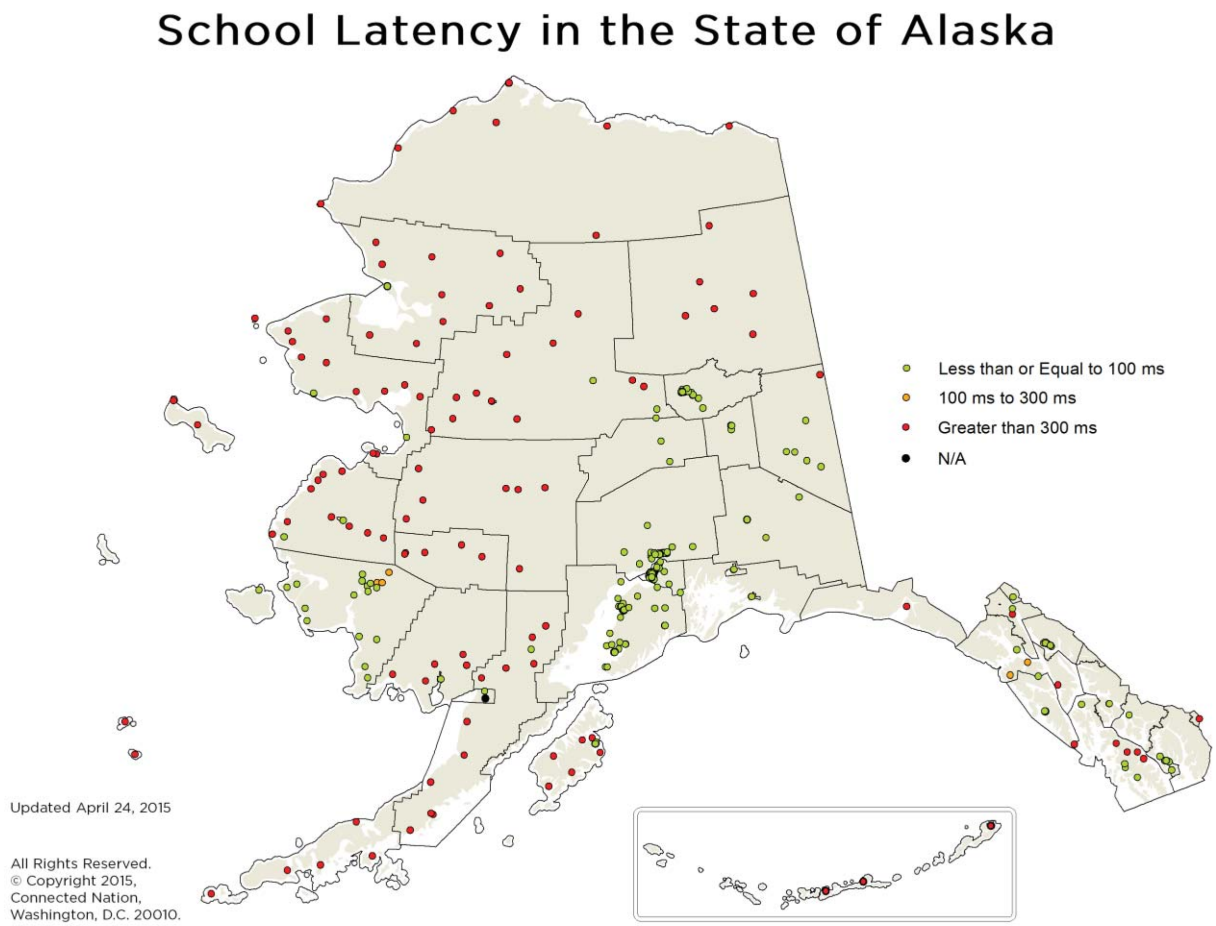
Table 9: Latency's Impact on Student Device Use

	Students	Devices/ Students	Total Broadband Monthly Cost/Student-Staff	Kbps/Student-Staff
100 ms or better	112,650	0.56	$15.91	261
100 ms to 300 ms	819	0.68	$177.04	441
Greater than 300 ms	10,716	0.93	$160.41	70
Statewide	**124,185**	**0.59**	**$29.79**	**246**

Table 9 shows that schools suffering from high latency are nevertheless committed to digital technology and learning. These schools tend to have significantly more devices (computers, laptops, or tablets) per student, nearly one for each student in audited schools. In addition, these schools pay as much per month for broadband as schools in the best quality latency tier. However, the broadband capacity these schools receive for that cost is substantially lower – 70 Kbps for each student and staff member, compared to 261 Kbps for each student and staff member in schools with latency at 100 ms or better.

Schools facing latency challenges are generally located off the road and ferry system and in the remote areas of the state. The following map of Audit latency test results by latency groupings, demonstrates that latency issues persist in the rural and remote areas of the state where wireline and even fixed wireless/microwave capacity is either not present or limited.

Figure 2: School Latency in the State of Alaska



In addition, on a per-student and staff basis, high-latency broadband costs schools ten **times** as much per month ($160 per month) as schools with latency of 100 ms or better ($16 per month). This is of course a function of the fact that these schools are located in rural and remote areas, are more likely to rely on satellite connectivity, and are less able to take advantage of the economies of scale and density associated with broadband networks.

VI. Rural and off-road schools have higher broadband capacity and more devices per student than urban or on-road schools.

Demonstrating the value of these tools as an important component of cost-effective education, demand for digital learning tools and applications is strong in the most rural and remote parts of Alaska.

Approximately two-thirds of K-12 public schools in Alaska are located in areas regarded by the E-rate program as rural, and these schools serve approximately 40% of Alaska K-12 public school students. As discussed below, the federal E-rate program funds a discount for broadband and other telecommunications costs purchased by all K-12 schools.

Despite a higher poverty rate and generally more costly broadband connectivity, students and staff at E-rate rural school districts have access to higher broadband capacity and considerably more Internet-connected devices on a per student basis than urban schools.

Case Study 3: Haines Borough School District

The Haines School District has taken great strides in ensuring their students have access to digital learning and has more devices available to students than the state average. Currently, the high school, located in southeastern Alaska with access primarily by ferry, has 1:1 initiatives implemented with middle school students expected to benefit from a similar program by the end of the year. The district has plans to connect elementary schools with 1:1 devices following these initial rollouts.

Although their network currently meets the needs of the students and staff, capacity is limiting the district's progress forward. Connections to higher education facilities, videoconferencing, two-way distance learning applications, and other tele-learning opportunities are not being fully utilized due to bandwidth issues. The community's residential Internet access also limits the use of broadband due to high costs and poor reliability of service.

Table 10: Rural and Urban Schools Breakdown

	Rural Schools	Urban Schools
Students	51,379	80,082
Poverty Rate	13.0%	8.4%
Kbps/Student-Staff	301	201
Broadband Cost/Student-Staff After E-rate Discount	$9.70/month	$2.07/month
Connected Devices/Student	.76	.46
Average Age of Devices	4.55 years	4.60 years

It is important to note that the monthly cost for connectivity reported above is **after** application of FCC E-rate discounts. The FCC E-rate program offers larger discounts to districts with higher poverty levels and in rural areas – and yet, even after these steeper discounts are applied, rural school districts spend more on broadband connectivity on a per student and staff basis than their Alaska urban counterparts. Additionally**,** these rural districts purchase more broadband capacity, relatively speaking. This finding demonstrates the clear need for greater broadband connectivity in rural Alaska.

Moreover, as discussed above, Alaska schools in both urban and rural areas are not on track to meet national benchmarks for broadband connectivity. While rural schools may currently offer higher broadband capacity and devices to students than urban schools, both are at risk of falling behind the robust school connectivity that is being deployed in the Lower 48. In addition, the Audit did not study or collect data on the relative use of devices in the classrooms by schools by teachers and students. A school may have more devices on a per-student basis but may not use or integrate those devices intensely into education.

Of course, in Alaska, simple “urban” and “rural” categories are generally insufficient in painting a complete picture. As Connect Alaska field engineers traveled the state to investigate school connectivity, they learned first-hand how many communities and school districts are accessible only through air or primarily through the ferry system. Table 11 demonstrates some important key differences between communities on the road system and those accessible only by air or water.

These findings demonstrate the clear demand for broadband in the most inaccessible areas of Alaska. On a per-student basis, there are **twice** as many connected student devices in schools not on the road system as in schools on the road system. In fact, there is nearly one device (computer, laptop, or tablet) for every student in schools that are not on the road system. The most inaccessible schools, reachable only through air with high poverty levels, pay considerably more per month for broadband connectivity and have low broadband speeds, yet these institutions provide their students with many connected devices that are considerably more state-of-the-art than other districts.

Table 11: District Breakdown Based on Accessibility

	Schools on Road System	Schools Accessible Primarily via Ferry	Schools Accessible via Air
Schools	249	89	168
Students	93,429	14,497	23,535
Poverty Rate	8.5%	9.1%	21.0%
Kbps/Student-Staff	249	466	79
Broadband Cost/Student-Staff After E-rate Discount	$2.48/month	$9.34/month	$16.20/month
Connected Devices/Student	.46	.92	.96
Average Age of Devices	4.72 years	5.24 years	3.74 years

Case Study 4: Evergreen Elementary School, Wrangell Public School District

Wrangell Public School District has a long history of using technology to enhance education. The district is located in southeastern Alaska near the Stikine River serving the community of Wrangell, Alaska.

Wrangell Public School District's network currently supports a 1:1 laptop program for all students, elementary school through high school. The 1:1 initiative for grades 2 through 12 was part of the Association of Alaska School Boards' Consortium for Digital Learning project which has been in place for 8 years, and after great success, the district recently expanded the 1:1 program to include all elementary school students.

While the network is able to support the elementary, middle, and high school programs, the primary wing of Evergreen Elementary is in great need of a wiring update to increase bandwidth. With additional bandwidth, the district could provide a wider variety of course offerings to students in order to expand on the catalog currently available. Greater bandwidth could also support the existing cloud-based courses and curriculum presently limited in usability due to occasionally slow Internet access. With a greater ability to utilize cloud-based computer services, generally, the district could eliminate locally based services saving costs and streamlining maintenance.

VII. School districts serving predominantly Native American students face substantial broadband capacity challenges.

Of the approximately 131,000 students in the Alaska K-12 public education system, 23.6% are Native Americans.[5] However, in most school districts in Alaska, Native American students are the single largest ethnic group.[6] Unfortunately, school districts that serve predominantly Native American students are among the most disconnected school districts in the state.

Table 12: Native American Students Access Compared to School Districts

	Majority Native American Students	All Other School Districts
School Districts	28	24
Students	23,724	107,700
Poverty Rate	21.4%	8.6%
Kbps/Student-Staff	86	278
Broadband Cost/Student-Staff After E-rate Discount	$16.4/month	$3.32/month
Connected Devices/Student	.98	.52
Average Age of Devices	3.82 years	4.82 years

Many of these school districts are in rural and remote areas, and the data are consistent with findings on the connectivity challenges faced by schools in all rural and remote areas. The data demonstrate that like other remote communities, these schools are trying to bring technology to the classroom at an even greater rate than other schools. However, the cost and quality of connectivity remains a considerable challenge.

[5] For Alaska Department of Education and Early Development enrollment data by grade by ethnicity, *see* http://education.alaska.gov/stats/,

[6] For demographic data published by the National Center for Educational Statistics, U.S. Department of Education, *see* http://nces.ed.gov/surveys/sdds/ed/profiles/#2/DP03_88/5/natural-breaks/db.

Case Study 5: Hoonah City School District

The Hoonah City School District faces a bandwidth issue preventing them from utilizing many services. Currently, the district, which is primarily accessed by ferry, operates a network with 6 Mbps symmetrical service including 1.5 Mbps service refunded to the school by the Library. In the near future, the funding for the library service will cease to exist so the district must solely fund their networks and thus determine where the dollars for service will come from. The network is already at about 50% capacity most of the day, while many services are not used and are closely managed due to limited bandwidth.

Because of the broadband challenges, schools in the Hoonah City School District cannot use many of the services expected to be available each day. Students and teachers are missing out on digital education tools such as video streaming, distance learning applications, and social media opportunities. With expanded bandwidth, students can take advantage of e-learning materials, and teachers and staff can benefit from online professional development.

VIII. Most Alaska school districts have WANS, but those networks generally do not meet nationwide benchmarks.

Wide Area Networks (WANs) are connections between schools that allow for sharing of resources and applications within a district. WANs benefit education by allowing for distance learning opportunities and access to content on a district-wide basis, without requiring each school to have their own Internet connection to access certain resources. For many remote districts in Alaska that rely on satellite connections to the public Internet, a WAN can be important component of digital learning and allow for cost-effective sharing of resources. For example, if a district had a robust WAN that connects schools in that district, a video or application used to teach a lesson need only be downloaded once from the Internet, and then could be shared with all schools through the WAN.

Recognizing the value of district WANs, the FCC has established a long-term benchmark for scalable WAN connectivity of 10 Gbps for every 1,000 students, or 10 Mbps for each student. The FCC has noted that this target is one that is flexible based on school and district size.

Nearly all school districts audited (42 of 52) have a district WAN, but the capacity of those WANs varies considerably. Nearly all school district WANs in Alaska do not meet the FCC capacity target, which indicates that Alaska school districts may not be in a position to utilize these WANs as important cost-saving tools for education.

Table 13 shows that while many Alaska school districts have WANs, these WANs generally do not have sufficiently robust capacity to meet the FCC nationwide benchmark. Indeed, of the 42 Alaska school districts with WANs, only 3 district WANs meet the nationwide benchmark.

Table 13: WAN Capacity Averages

Average WAN Capacity (of districts with WANs)	1.3 Mbps for each student
Median WAN Capacity (of districts with WANs)	0.28 Mbps for each student
Number of Districts with WAN Capacity of 10 Mbps/student or greater	3

IX. Nearly all Alaska classrooms are connected via Wi-Fi, but schools report the need to increase the quality of those connections.

Unlike broadband Internet connectivity to school buildings and WAN capacity between school buildings, the FCC has not established a specific target for on-campus wireless (usually Wi-Fi) connectivity on school campuses. However, in 2014 the FCC established a dedicated, $1 billion/year fund directed at ensuring that sufficient federal resources were available to school districts to build on-campus internal networks. Every school district has access to this fund, which will provide district funding of $150 per student over five years to build and maintain these on-campus networks.

As part of the Audit, Connect Alaska sought to determine how many instructional areas in Alaska schools are connected to wired Ethernet or Wi-Fi networks and the general satisfaction with the quality of those networks. Schools report that the vast majority (96%) of instructional areas in Alaska schools are connected to on-campus Wi-Fi. However, over two-thirds of schools state that Wi-Fi access is inadequate for instruction.

Table 14: Wi-Fi Capacity by Region

	Wi-Fi Adequate	Elementary	K12	Middle/High	Statewide
Rural	No	77%	47%	67%	58%
	Yes	21%	51%	33%	40%
Urban	No	100%	88%	98%	99%
	Yes	0%	12%	2%	1%
Statewide	No	88%	48%	80%	70%
	Yes	11%	49%	20%	29%

Elementary schools report the largest dissatisfaction with Wi-Fi network quality, with 88% of schools reporting that their on-campus Wi-Fi networks are inadequate for instructional needs. The pressure on Wi-Fi network quality is perhaps most felt in larger, urban schools in which 99% of schools report that their Wi-Fi network capacity is inadequate.

Case Study 6: Yakutat Elementary School, Yakutat School District

The Yakutat Elementary School, a small school located in southeastern Alaska in a district accessible primarily by ferry, is in great need of bandwidth and network reliability. To attempt to access any type of online content, the school must use a combination of the Wi-Fi and LAN hookups. According to the school, if two users are utilizing online content, it eliminates any others from accessing the Internet. Due to network challenges, minimum bandwidth, and satellite latency issues, students are not experiencing the type of connectivity that is needed in today's global educational system. In order for students in this rural district to have access to online testing and a robust curriculum of digital learning content, funding for network rebuilding and reconfiguration as well as access to great bandwidth must be made available.

Regional Analysis of the School Broadband Gap

Since Alaska covers such a massive land area and contains a diverse array of communities, rural, and bush areas, it is important to compare the adoption and use of broadband technology by Alaska schools not simply to nationwide benchmarks but also to their peer groups. To facilitate these comparisons, this Report has grouped Alaska K-12 schools into five geographic regions: Central, Southeastern, Western, Northern, and Southwestern.

The Alaska School Broadband Audit website also allows the user to compare their own school and district to any self-selected peer group, as well as state averages.

As noted in the statewide findings above, the most rural and remote school districts in Alaska face the largest broadband adoption and cost challenges. However, those gaps vary considerably by region. Comparing school districts by region reveals a number of striking findings about the unique broadband challenges presented by Alaska's geography.

Table 15: District Sizes by Region

Region	School Districts	Students
Central	Alaska Gateway School District	404
	Anchorage School District	48,154
	Chugach School District	310
	Copper River School District	442
	Cordova City School District	349
	Delta Greely School District	815
	Denali Borough School District	888
	Fairbanks North Star Borough School District	13,891
	Galena City School District	4,384
	Iditarod Area School District	333
	Kenai Peninsula Borough School District	9,150
	Kodiak Island Borough School District	2,477
	Matanuska-Susitna Borough School District	18,037
	Nenana City School District	1,040
	Valdez City Schools	608
	Total	**101,282**
Northern	Bering Strait School District	1,848
	North Slope Borough School District	2,017
	Northwest Arctic Borough School District	2,126
	Tanana City School District	39
	Yukon Flats School District	247
	Yukon-Koyukuk School District	1,495
	Total	**7,772**

Southeastern	Annette Island School District	381
	Chatham School District	172
	Craig City School District	576
	Haines Borough School District	280
	Hoonah City School District	117
	Hydaburg City School District	80
	Juneau Borough School District	4,813
	Kake City School District	111
	Ketchikan Gateway Borough School District	2,474
	Klawock City School District	123
	Pelican City School District	13
	Petersburg City School District	440
	Sitka School District	1,402
	Skagway School District	100
	Southeast Island School District	201
	Wrangell Public School District	278
	Yakutat School District	110
	Total	**1,1671**
Southwestern	Aleutian Region School District	37
	Aleutians East Borough School District	246
	Bristol Bay Borough School District	134
	Dillingham City School District	469
	Lake and Peninsula Borough School District	336
	Pribilof Island School District	92
	Southwest Region School District	602
	Unalaska City School District	399
	Total	**2,315**
Western	Kashunamiut School District	325
	Kuspuk School District	387
	Lower Kuskokwim School District	4,285
	Lower Yukon School District	2,054
	Nome Public Schools	700
	Saint Mary's School District	213
	Yupiit School District	457
	Total	**8,421**

This section will compare the broadband network capacity of schools in each region, the cost of that capacity, and the number and age of connected devices (PC, laptop, or tablet) available to students and faculty for instructional purposes. Table 16 below provides some summary data on the capacity, cost, and use of devices for each region. The summary table demonstrates significant variations among Alaska schools when examined on a regional basis. Each regional discussion that follows will discuss the particular challenge faced in connecting students and educators in those regions.

Table 16: Capacity, Cost, and Use of Devices for Each Region

Region	CAPACITY	COST			DEVICES	
	Av. Kbps/ Student-Staff	Total Broadband Monthly Cost	Total Monthly Cost per Student-Staff	Total Monthly Cost per Mbps	Number of Devices/ Student	Average Age of Devices
Central	265	$1,216,173	$11.65	$44.43	0.47	4.72
Northern	52	$993,342	$101.30	$1955.40	0.97	4.01
Southeastern	383	$427,755	$34.04	$89.83	0.90	5.37
Southwestern	55	$312,079	$117.32	$2122.99	1.06	4.76
Western	115	$1,192,500	$124.54	$1083.11	0.94	3.11
Statewide	**246**	**$4,141,849**	**$29.79**	**$122.20**	**0.59**	**4.57**

Central Region

The majority of K-12 schools are in the **Central Region**, which includes the large districts of Anchorage, Fairbanks, Kenai, and Matanuska-Susitna. Districts in the Central Region serve over 100,000 K-12 students, 77% of all K-12 public school students in Alaska. The most important characteristic of the Central region is that it contains all of the schools in the state that are connected to the road system – indeed, 91% of the schools in the Central Region are on the state road system, while none of the schools in the other four regions are accessible as such. That said, 25 audited schools in the Central Region are generally accessible by air or ferry. Of the five regions, the Central Region has the lowest poverty rate (8.6%).

Not surprisingly given its geography, Central Region schools have among the highest broadband speeds on a per-student and staff basis and the most cost-effective prices. Schools in the region do face a number of challenges, potentially because of their large student populations. In particular, while many schools in the Central Region meet the short-run E-rate broadband capacity target of 100 Kbps/student and staff, only 8% of the schools meet the 2020 goal of 1000 Kbps/student and staff. In addition, the Central Region has the lowest number of connected instructional devices in the entire state – 0.47 – one-half less than other regions. Indeed, if one excludes the Central Region from analysis, Alaska schools in the other four regions have nearly one connected device for each student.

Central Region

- **101,282 students**
- **15 school districts**
    - ***Alaska Gateway***
    - ***Anchorage***
    - ***Chugach***
    - ***Copper River***
    - ***Cordova City***
    - ***Delta Greely***
    - ***Denali Borough***
    - ***Fairbanks North Star Borough***
    - ***Galena City***
    - ***Iditarod Area***
    - ***Kenai Peninsula Borough***
    - ***Kodiak Island Borough***
    - ***Matanuska-Susitna Borough***
    - ***Nenana City***
    - ***Valdez City***
- **282 schools (Audited:266)**
    - **134 Elementary**
    - **79 Middle/High**
    - **53 K-12**
    - **25 not on road system**
- **8% Native American student population**

Case Study 7: Kenai Peninsula Borough School District

The Kenai Peninsula Borough School District, located in central Alaska and serving one of the largest student populations in the state, operates a diverse network across a varied district. The school district serves institutions from small, K-12 schools in remote Alaska to large, metropolitan high schools, all with various types of technology for backhaul.

One school in the district, Soldotna High School, manages bandwidth based on school needs and availability while managing networks at all locations. Speed tests are utilized at the school to verify network performance. While on site, Connect Alaska engineers conducted several tests utilizing a Minneapolis server location. The results were positive with all latency readings falling below the 150 milliseconds and most at or around 90 milliseconds.

Supporting widespread broadband usage and implementation among students allows for a variety of technology to be used for instruction in the classroom. Soldotna provides laptops for Smart boards, utilizes multiple portables, and redistributes the technology devices as needed to get maximum use. All portables are wired with cat 5 infrastructure when deployed and are all equipped with VoIP services to enhance online engagement.

Connect Alaska observed that Kenai Peninsula Borough has well-managed the great variety and diverse needs across this school district – students are well connected to broadband technology and getting a wealth of information from online tools daily.

Progress Toward Broadband Capacity Benchmarks

The average student and staff member in the Central Region has broadband network capacity of 265 Kbps. Table 17 below lists, by district, the average broadband capacity for each student and staff member. These numbers are averaged by reference to student body and faculty size.

Table 17: Broadband Speed per Student and Staff by School District (Central Region)

Central Region School District	Kbps/ Student-Staff
Alaska Gateway School District	113
Anchorage School District	69
Chugach School District	37
Copper River School District	135
Cordova City School District	49
Delta Greely School District	134
Denali Borough School District	249
Fairbanks North Star Borough School District	437
Galena City School District	36
Iditarod Area School District	126
Kenai Peninsula Borough School District	468
Kodiak Island Borough School District	907
Matanuska-Susitna Borough School District	498
Nenana City School District	89
Valdez City Schools	99
Average	**265**

When examined on an individual school basis, only 8% of schools in the Central District have capacity of 1000 Kbps for each student and staff, the E-rate connectivity 2020 goal. Thirty-six percent (36%) of schools in the Central District do not have capacity of 100 Kbps, the short-term capacity goal for the E-rate program. The following chart compares these schools to schools in the Central Region that meet the short-term goal.

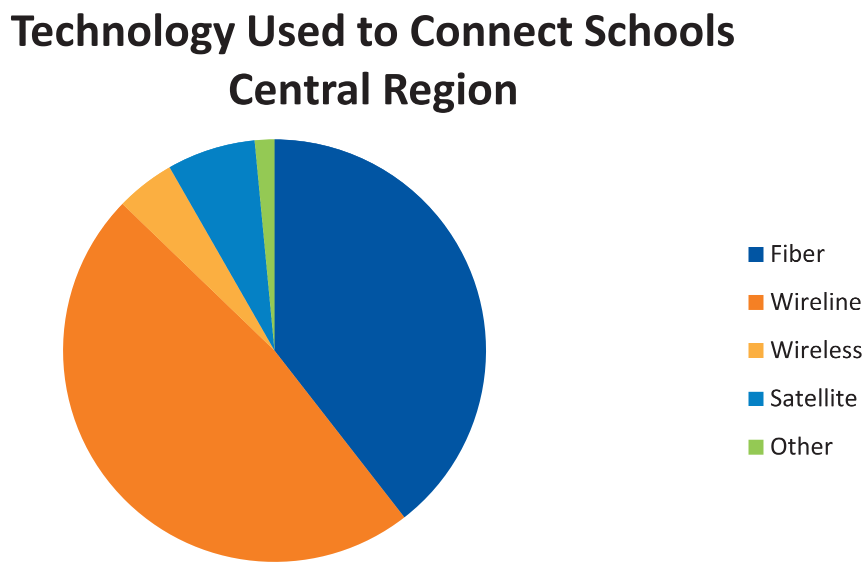
Table 18: Connectivity Comparison (Central Region)

	Schools Meeting 100 Kbps/Student-Staff Target	Schools Not Meeting 100 Kbps/Student-Staff Target
Kbps/student-staff, average	449	52
Total monthly cost per Mbps	$33.61	$152.78
Devices/student	0.48	0.47
Average age of devices	4.55	4.92

Technology Breakdown

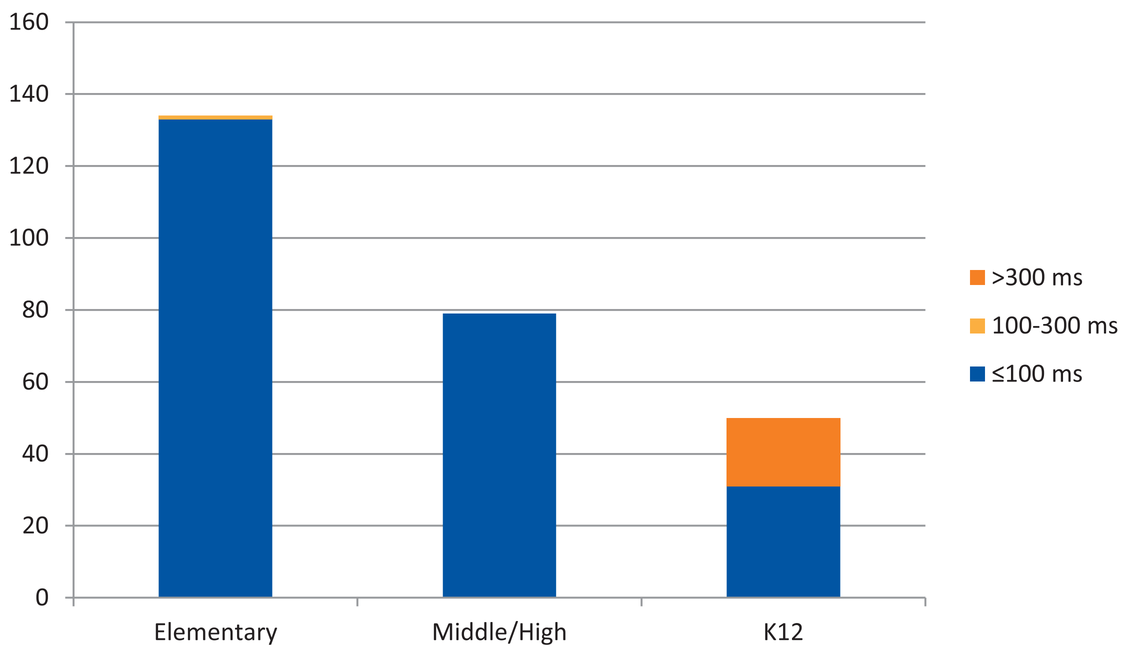
The majority of schools in the Central region are served with a wired network connection, with 105 schools audited having fiber optic connections.

Figure 3: Technology Used to Connect Schools (Central Region)



Most schools in the Central region have latency at or better than 100 ms, which means that they have the quality of service useful for online-testing, video educational applications, and distance learning.

Figure 4: Latency Comparison Based on School Type (Central Region)



There are 18 schools in the Central Region connected solely by satellite, and all of these schools have latency greater than 300 ms.

Cost

As to be expected from its more-accessible and less-rural nature, the cost of connectivity in the Central Region is the lowest in the state. The following tables compare the total monthly cost for broadband capacity at Central Region schools based on technology used to connect the school. The tables measure these costs with regard to total cost per student and staff as well as total cost on a per-megabit basis.

Figures 5 and 6 show the difference in costs between fiber, wireless, and other wireline technologies in the Central Region. The cost of satellite broadband services used at some Central Region schools is considerably higher than these other technologies -- $385.88 per month for each student and staff and $2,524.59 per month per Mbps.

Figure 5: Broadband Monthly Cost/ Student and Staff (Central Region)

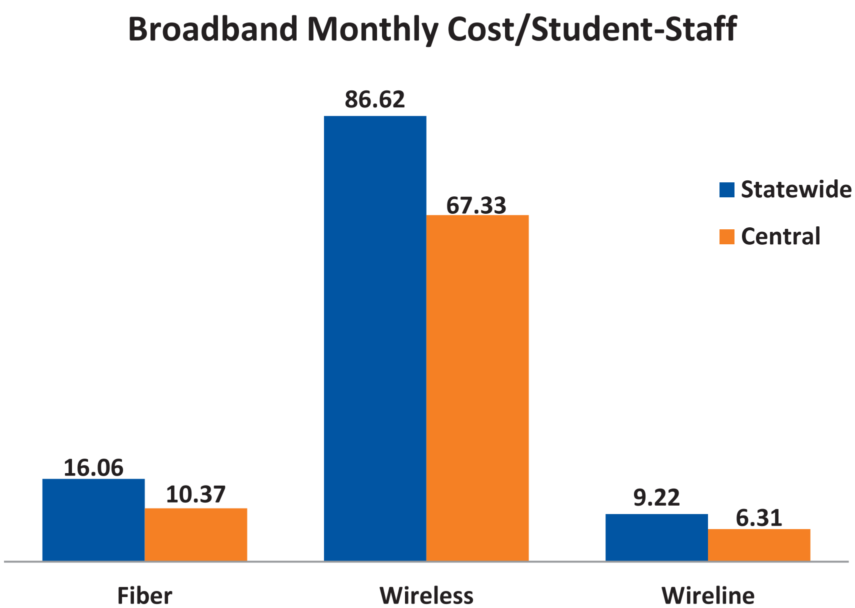
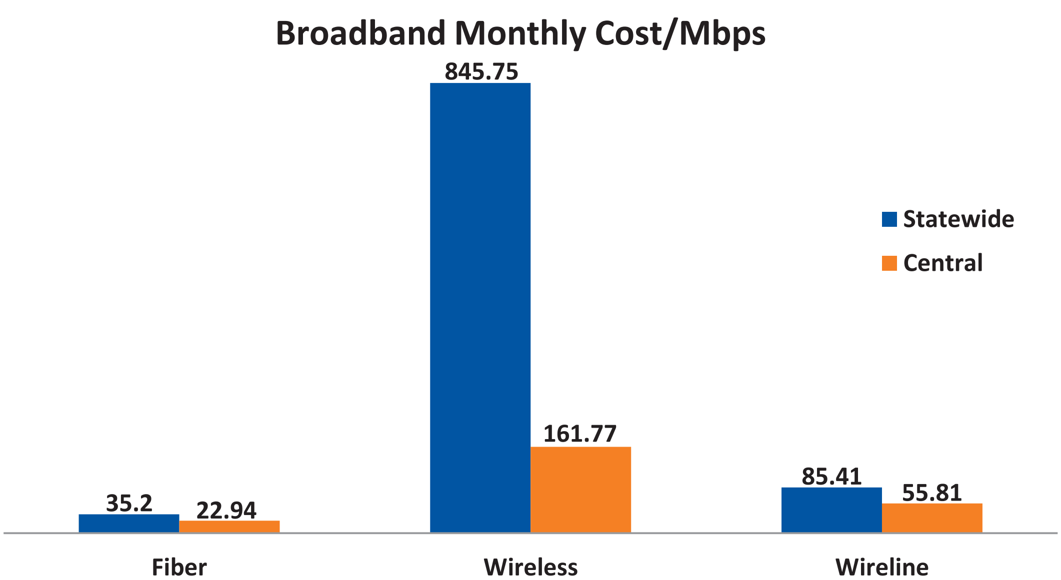


Figure 6: Broadband Monthly Cost/Mbps (Central Region)



Devices

As Table 16 above shows, when measured on a per-student basis, there are fewer connected instructional devices in the Central Region than the rest of the state, 0.47 compared to 0.94.

Case Study 8: Lathrop High School, Fairbanks North Star Borough School District

Lathrop High School, located in the large Fairbanks North Star Borough School District, is Fairbanks' largest school and considered one of the top schools in the state. Connect Alaska engineers were impressed with the school's demonstrated successful network management and the robust connectivity for students and faculty. The network is locally managed and provides suitable bandwidth to meet the needs of the school including security cameras. Though increasing bandwidth is not an affordable option at this time, the network is constantly being upgraded to maintain appropriate service for student and faculty usage.

Lathrop High School has ambitions to pursue a 1:1 or Bring Your Own Device (BYOD) initiatives so that its emerging job-seekers have access to twenty-first century technology in school. The current network does not have capacity to support this vision. Significant upgrades resulting in greater bandwidth will need to be realized before this is possible. Greater bandwidth could also allow for the availability of widespread cloud storage which would additionally provide a great tool for the school as they aim to continue to connect their students in the most robust manner possible.

Case Study 9: Kodiak Island Borough School District

According to Connect Alaska's district-level analysis, Kodiak Island Borough School District exceeds state averages for student download speed targets and even exceeds the national benchmark in its elementary schools. However, that is not the case in many of the district's rural schools. While existing fiber technology bandwidth is sufficient for city schools such as Kodiak High School, many of the district's rural schools are on satellite backhaul with dedicated bandwidth thus limiting the potential for computer technology use in the classrooms.

Kodiak High School is currently undergoing an expansion of facilities with ongoing upgrades to their wireless networks within the school that will serve the 723 students and 90 faculty members. The city schools additionally utilize microwave to extend their reach to support facilities temporarily dislocated due to the ongoing expansion construction, but rural schools in the district remain at a disadvantage.

In the district's rural schools, the current level of bandwidth limits expansion and use of digital learning tools that would enhance teaching and learning. One school offers a successful Robotics class that uses the maximum bandwidth capabilities available. By increasing bandwidth, more opportunities such as this class and others can be made available to students looking to learn technology and engineering skills. In terms of devices, a refresh is currently being deployed on a five-year basis with some catch-up required due to budgeting and available funding.

Southeastern Region

Southeastern Region school districts are accessible primarily through the water ferry network; however, the 72 schools in the Southeastern Region have the highest broadband connectivity in the state, 383 Kbps per student and staff on average, considerably higher than the Central Region even though the cost of that connectivity in the Southeast is greater, $34.04 per student and staff, per month. With an estimated poverty rate of 8.8%, the Southeastern Region boasts, alongside the Central Region, the lowest rates in the state.

Southeastern Region

- **11,671 students**
- **17 school districts:**
  - ***Annette Island***
  - ***Chatham***
  - ***Craig City***
  - ***Haines Borough***
  - ***Hoonah City***
  - ***Hydaburg City***
  - ***Juneau Borough***
  - ***Kake City***
  - ***Ketchikan Gateway Borough***
  - ***Klawock City***
  - ***Pelican City***
  - ***Petersburg City***
  - ***Sitka***
  - ***Skagway***
  - ***Southeast Island***
  - ***Wrangell Public***
  - ***Yakutat***
- **72 schools (Audited: 63)**
  - ***18 Elementary***
  - ***24 Middle/High***
  - ***21 K-12***
  - ***63 not on road system***
- **18% Native American student population**

Southeastern Region schools serve 11,671 students with the highest broadband speeds per student and staff in Alaska. With the average speeds surpassing the short-term E-rate broadband capacity target of 100 Kbps, only 10% of the schools meet the 2020 long-term goal of 1000 Kbps per student and staff. Despite high speeds, however, students are often using outdated technology devices. Of the distributed devices among student and faculties in the region, the average age of those devices is the oldest in the state at 5.37 years old. This age is significantly higher than the state average of 4.57 years.

Case Study 10: Petersburg High School, Petersburg City School District

Petersburg High School, in Petersburg City School District, despite older infrastructure and remote location, is taking important steps to ensure the connectedness of its students. With a well-managed network and significant use of spectrum available, the school is regularly testing new technology applications to be implemented across the campus. Students are very active in reviewing and beta testing new software and programs to be utilized on the internal network as well as on supplied devices. The investment in new and more advanced applications is embraced by the staff and students. Additionally, students are involved in keeping the school network viable and operable as the administration focuses on implementation of 1:1 initiatives and other programs that will bring the best technology and e-learning to this southeastern Alaska school district.

Progress Toward Broadband Capacity Benchmarks

As stated above, the average student and staff in Southeastern schools are served by speeds of, on average, 383 Kbps. Table 19 shows the average broadband capacity averaged by student body and faculty size for each school district.

Table 19: Broadband Speed per Student and Staff by School District (Southeastern Region)

Southeastern Region School District	Kbps/Student-Staff
Annette Island School District	323
Chatham School District	150
Craig City School District	146
Haines Borough School District	128
Hoonah City School District	30
Hydaburg City School District	274
Juneau Borough School District	307
Kake City School District	127
Ketchikan Gateway Borough School District	733
Klawock City School District	94
Pelican City School District	83
Petersburg City School District	141
Sitka School District	498
Skagway School District	85
Southeast Island School District	321
Wrangell Public School District	242
Yakutat School District	109
Average	383

In examining schools on an individual basis, it is clear that only 10% of schools in the region meet the E-rate long-term goal of 1000 Kbps per student and staff benchmark. Even more important today, 22% of schools do not meet the short-term E-rate goal of 100 Kbps. The following table compares these schools to schools in the Central Region that meet the short-term goal.

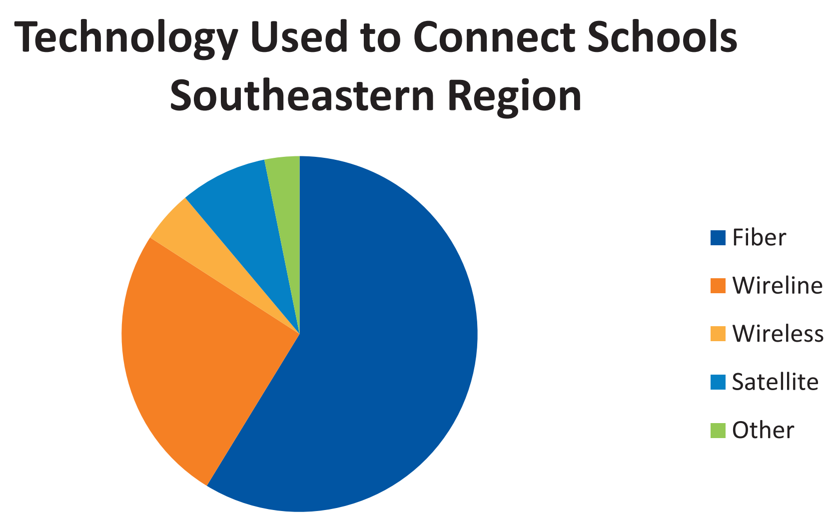
Table 20: Connectivity Comparison (Southeastern Region)

	Schools Meeting 100 Kbps/Student-Staff Target	Schools Not Meeting 100 Kbps/Student-Staff Target
Kbps/student-staff, average	520	57
Total monthly cost per Mbps	$76.07	$330.48
Devices/student	0.85	1.04
Average age of devices	5.34	5.43

Technology Breakdown

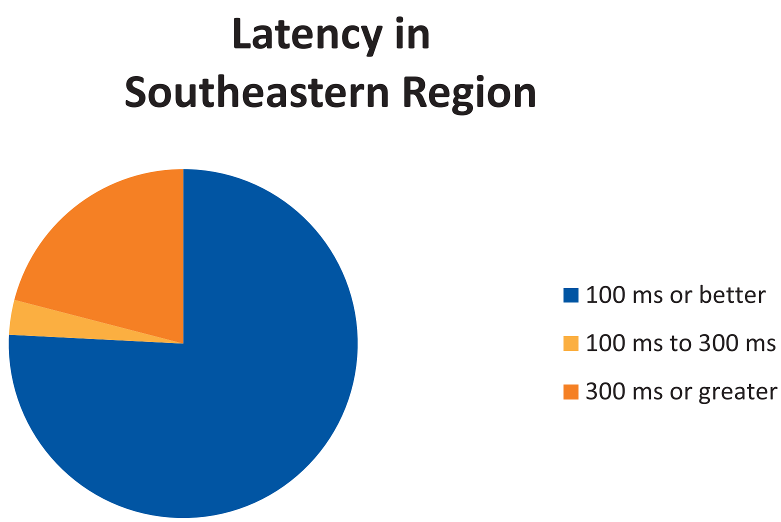
In the Southeastern Region, the majority of schools are served by a wired network, with approximately 59% of schools audited served by fiber connections (37 schools).

Figure 7: Technology Used to Connect Schools (Southeastern Region)



When looking at the Southeastern Region's latency, about 76% of schools have 100 ms or better, the speed tier needed for reliable online-testing and application usage. In a district primarily accessible by water, proper latency is important for distance learning uses; however, 21% of schools in the region indicated latency of greater than 300 ms, a level creating significant challenges for schools looking to fully utilize their technology.

Figure 8: Latency Comparison Based on School Type (Southeastern Region)



Cost

While the cost of broadband is higher than that in the Central Region, the cost per student and staff is significantly lower than that of the other three regions in the state. Schools pay, on average, $34.04 per student and staff in the Southeastern Region.

Devices

In the Southeastern Region, nearly every student has a connected instructional device with 0.90 devices per student observed in the area. While the number of devices is encouraging, the age of those devices is significantly older than other regions in Alaska. Devices in the region are, on average, 5.37 years old, representing potentially out-of-date technology in schools that may have trouble making use of online and digital applications.

Case Study 10: Kake School District

Located in southeastern Alaska, Kake City School District, accessible primarily by ferry, began an innovative 1:1 program this year utilizing iPads. To make the program a success, the district must rely heavily on the network. To this end, Kake School District recently completed a major wireless update providing fast access to the devices and better management to optimize the network.

Superintendent Shipley and Technology Director Jeff VanTrease have put together a program that is increasing student opportunities for courses as well as accelerating their learning with mobile tools, but additional bandwidth would allow them to fully realize their vision. Faculty would like to utilize virtual field trips to expose the students to experiences outside of the village. Also, students leave the district for sporting or other events and could take advantage of the mobile technology to remain in touch with teachers to ensure learning never stops and can occur anywhere.

The technology department sees additional advantages of increased bandwidth with the option to provide cloud-based services. These services would be reachable inside or outside Kake to both faculty and students. Also, by doing so the district could eliminate high-cost services currently provided internally by taking advantage of the cloud and removing the need for hardware and management by district staff.

Western Region

Located in areas only accessible by air, **Western Region school districts** are extremely rural with a large percentage of the district schools housing K-12. The district's nearly 8,500 students are spread out over 7 school districts and in 57 schools, 88% of which are served by wireless or satellite broadband service. The Western Region has a significant poverty rate of 23.5%, which is the highest among Alaska regions, and also comprises the highest Native American population in the state.

Due to the remote and rural locations of most of the schools, it is not surprising that the cost of service is the highest in the state of Alaska, and by a rather large margin. Schools pay, on average, $124.54 per student and staff per month for service and only maintain adequate speeds at, on average, 115 Kbps per student and staff. With 61% of the districts in the region not meeting the E-rate short-term goal of 100 Kbps per student and staff, even fewer, 95%, don't meet the long-term goal of 1000 Kbps per student and staff. Nonetheless, nearly every student in the district has access to a connected educational device and the average age of these devices is the lowest in the state at 3.11 years.

Western Region

- **8,421 students**
- **7 school districts:**
  - ***Kashunamiut***
  - ***Kuspuk***
  - ***Lower Kuskokwim***
  - ***Lower Yukon***
  - ***Nome Public***
  - ***Saint Mary's***
  - ***Yupiit***
- **57 schools (Audited 56)**
  - ***7 Elementary***
  - ***9 Middle/High***
  - ***40 K-12***
  - ***56 not on road system***
- **84% Native American student population**

Progress Toward Benchmark Capacity Benchmarks

On average, each student and staff in the Western Region has access to 115 Kbps. Below, the table lists the average network capacity each school district per student and staff, weighted by student body and faculty size.

Table 21: Broadband Speed per Student and Staff by School District (Western Region)

Western Region School District	Kbps/Student-Staff
Kashunamiut School District	24
Kuspuk School District	114
Lower Kuskokwim School District	186
Lower Yukon School District	22
Nome Public Schools	58
Saint Mary's School District	26
Yupiit School District	55
Average	115

As the E-rate program has set benchmarks for broadband capacity, only 39% of schools in the Western District have access to the short-term goal of 100 Kbps and even less, 5%, have access to the 1000 Kbps 2020 benchmark. Table 22 compares the schools to others in the region that meet the short-term goal.

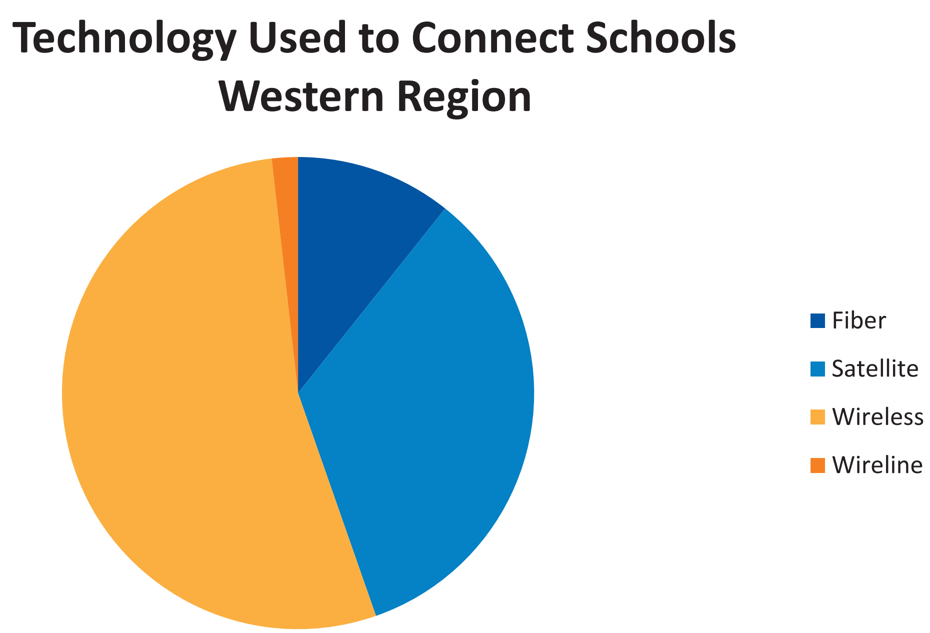
Table 22: Connectivity Comparison (Western Region)

	Schools Meeting 100 Kbps/Student-Staff Target	Schools Not Meeting 100 Kbps/Student-Staff Target
Kbps/student-staff, average	331	43
Total monthly cost per Mbps	$448.22	$2717.72
Devices/Student	1.03	0.91
Average age of devices	2.86	3.21

Technology Breakdown

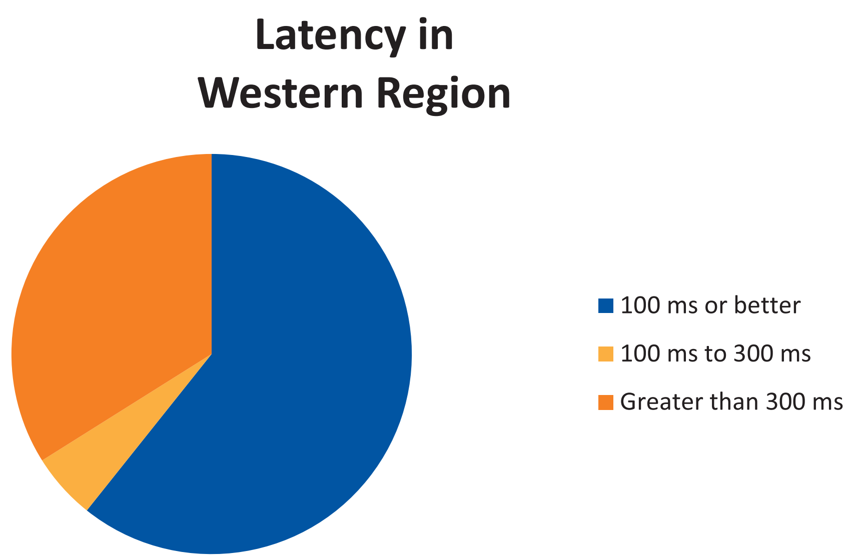
Due to the remote nature of the districts in the Western Region of Alaska, wired connectivity is often not an option for schools. As a result, satellite and wireless services are the only solution to their broadband, with approximately 88% of schools using these two services to connect their classrooms.

Figure 9: Technology Used to Connect Schools (Western Region)



In regard to latency, only about 60% of the schools within the Western Region have latency of 100 ms or greater, which is the benchmark the Audit uses for determining proper levels to stream videos, use distance learning and other applications, and take tests online.

Figure 10: Latency (Western Region)



Costs

As discussed, the cost of broadband in the Western Region is significantly higher than other regions in Alaska with schools paying approximately $124.54 per month per student and staff. With the remote nature and necessary use of satellite and wireless technology for coverage, schools are paying, on average, over ten times more for service than schools in the Central Region of Alaska.

Table 23: Broadband Monthly Cost by Platform (Western Region)

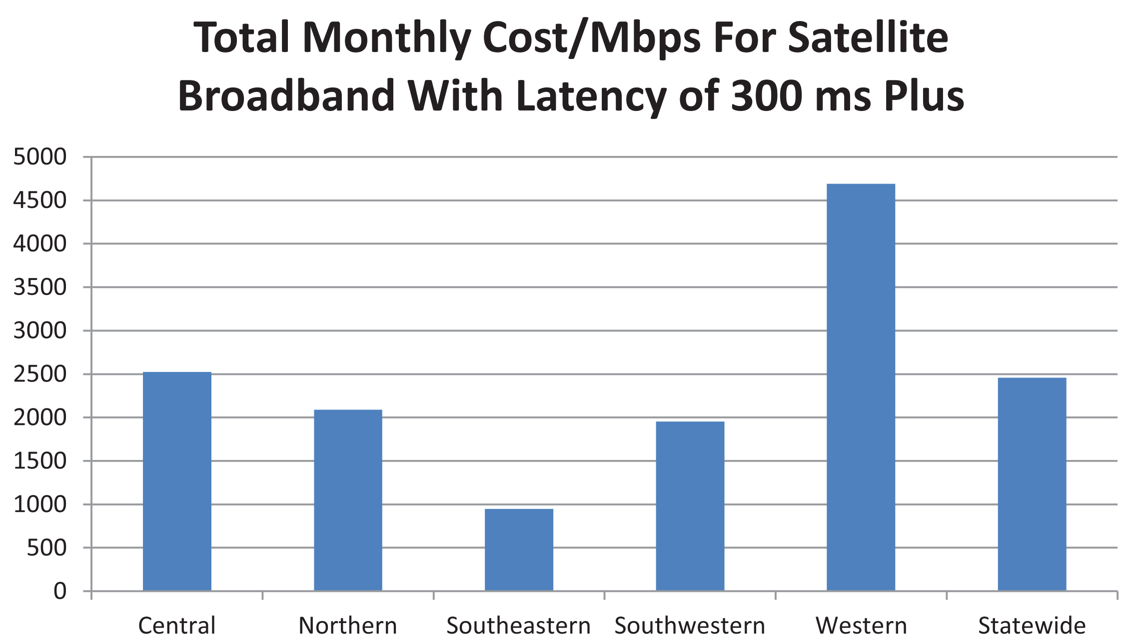
Platform	Broadband Monthly Cost/Student-Staff	Broadband Monthly Cost/Mbps
Fiber	$87.92	$212.77
Satellite	$167.55	$ 4,688.00
Wireless	$112.89	$ 1,637.07
Wireline	$117.16	$4,452.00
Average	**$124.54**	**$ 1,083.11**

Interestingly, the Audit shows that Western Region schools are paying substantially more for satellite broadband capacity than other schools in Alaska. The monthly cost per Mbps for a satellite broadband connection in the Western region is $4,688 per month, much higher than the cost per megabit for satellite connectivity in other regions.

Table 24: Regional Comparison of Broadband Costs and Speeds

Monthly Cost/Mbps	Satellite with Latency of 300 ms +	Other Technologies
Central	$2,525.00	$33.00
Northern	$2,088.00	$1,371.00
Southeastern	$948.00	$86.00
Southwestern	$1,951.00	$2386.00
Western	$4,688.00	$731.00
Statewide	$2,456.00	$70.00

Figure 11: Total Monthly Cost/Mbps for Satellite Broadband with Latency of 300 ms Plus



In theory, the cost of providing satellite connectivity should not vary significantly, and indeed, outside of the Western region, prices paid for satellite connections are more consistent. Variations in prices paid could be a function of whether competitive pressures are present and the procurement processes of individual school districts. In the Recommendations Section below, Connect Alaska recommends that the state and school districts improve procurement processes to take better advantage of potentially cost-saving measures like purchasing consortia.

Devices

With nearly one device per student (0.94 devices per student) and, on average, the newest devices in the state compared to other regions, students in Western Region districts have access to digital learning devices that have the ability to connect them, despite the remote location of many of the communities.

Case Study 12: Lower Yukon School District

Mountain Village schools of the Lower Yukon School District are only accessible by air and located in a remote, rural village in western Alaska. They choose to use satellite even though wireline service is available in most of its villages. Due to high costs and availability, the schools are unable to make the switch to lower latency, higher bandwidth options.

All of the schools within the Lower Yukon School District have satellite and a 5 Mbps network connection available for use across the network. This has allowed them to begin the process of incorporating distance learning, live video streaming, ConnectED initiatives, My Math and Reading Wonders programs, and distance learning connections with the Lower 48.

In order to have a usable experience, however, the network uses storage and caching equipment which is negatively impacted by the massive amounts of brownouts and blackouts the remote area often experiences. These power outages are hard on equipment, expensive to repair, and cause potentially long downtimes, causing students and teachers to lose access to on-line curriculum.

Although the schools are aiming to connect their students to the best of breed twenty-first century learning tools, electrical power outages, latency, bandwidth, and network dependability continue to serve as challenges for the area.

Northern Region

Northern Region school districts, only accessible by air, are located in rural areas of Alaska and serve 7,772 students. The 57 schools in the region are located in high poverty areas with nearly half of students in the audited schools eligible for free or reduced lunch. With an overwhelming number of schools in the region serving grades K-12, the six districts cover a large and remote part of the state.

With the slowest speeds in the state, the Northern Region districts have, on average, only 52 Kbps per student and staff of available bandwidth for school usage. This number falls well below the national E-rate short-term goal of 100 Kbps per student and staff with a majority of schools missing the benchmark. Additionally, no schools in the area meet the long-term E-rate goal of 1000 Kbps per student and staff. Despite slow speeds, however, districts maintain close to a 1:1 device ratio, although the average age of these devices is approximately 4 years old.

Northern Region

- **7,772 students**
- **6 school districts:**
  - ***Bering Strait***
  - ***North Slope Borough***
  - ***Northwest Arctic Borough***
  - ***Tanana City***
  - ***Yukon Flats***
  - ***Yukon-Koyukuk***
- **57 schools**
  - ***1 Elementary***
  - ***4 Middle/High***
  - ***52 K-12***
  - ***57 not on road system***
- **80% Native American student population**

Progress Toward Broadband Capacity Benchmarks

With the average speeds of 52 Kbps per student and staff, 34 of the regions 57 schools (60%) fall short of the E-rate's short-term goal of 100 Kbps per student and staff while all schools fall short of the long-term goals. As indicated in the chart below, Northern Region schools have a need for greater bandwidth capacity to meet the increasing demands of digital learning.

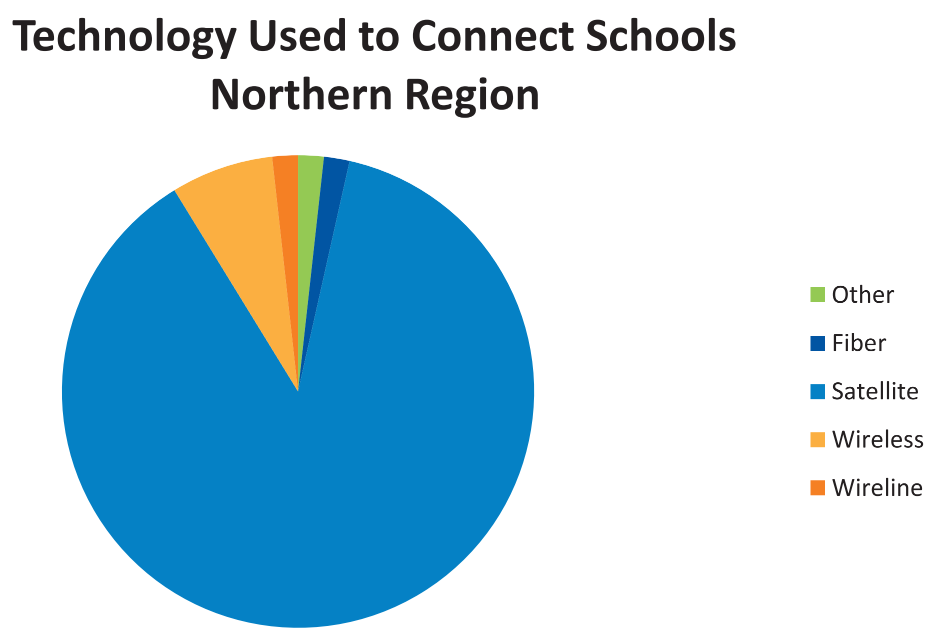
Table 25: Broadband Speed per Student and Staff by School District (Northern Region)

Northern Region School District	Kbps/Student-Staff
Bering Strait School District	55
North Slope Borough School District	69
Northwest Arctic Borough School District	26
Tanana City School District	149
Yukon Flats School District	109
Yukon-Koyukuk School District	59
Average	**52**

Technology Breakdown

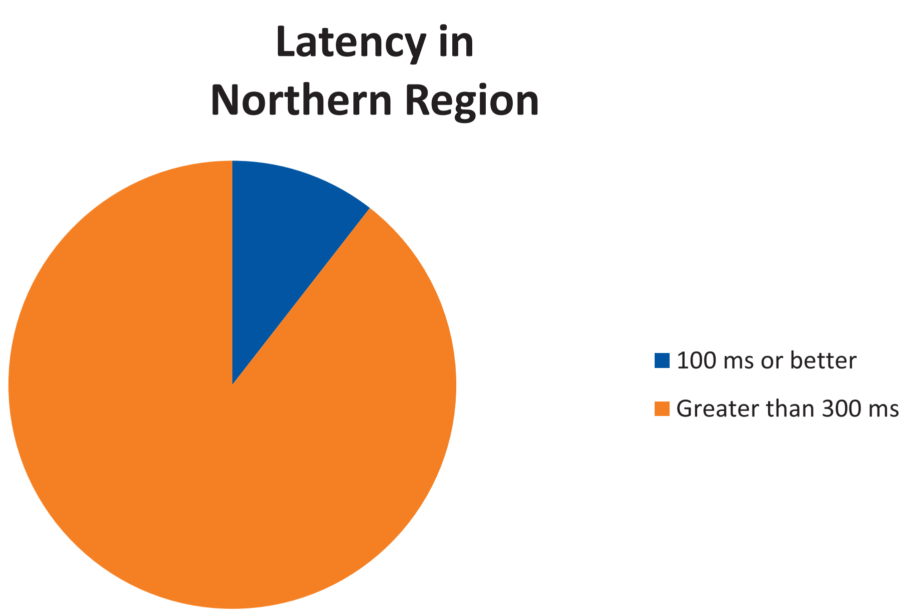
Schools in the Northern Region are almost exclusively served by satellite providers (88% of schools) with a small portion utilizing wireless technology. Only 2 schools use fiber or another wireline service, certainly accounting for the large amount of schools without robust access.

Figure 12: Technology Used to Connect Schools (Northern Region)



Latency is, not surprisingly, also an issue with Northern District schools. Eighty-nine percent (89%) of schools (or 51 of the 57 schools in the region) experience latency speeds of greater than 300 ms, the result of satellite connections and backhaul. In a remote area such as the Northern Region of Alaska, improvements in latency could offer numerous opportunities for useful distance learning applications.

Figure 13: Latency (Northern Region)



Cost

Costs in the Northern Region are above average for the state and significantly greater than the costs identified in the Central region of the state. Schools pay, on average, $101.30 monthly per student and staff for broadband services in the Northern part of Alaska (compared to $11.65 in the Central Region where schools are less rural and more accessible). The following tables indicate costs by technology at schools.

Table 26: Broadband Monthly Cost/ Student and Staff by Platform (Northern Region)

Platform	Monthly Cost/Student-Staff	Monthly Cost/Mbps
Fiber	$154.64	$1,875.00
Satellite	$140.32	$2,088.17
Wireless	$42.16	$1,738.20
Wireline	$13.33	$ 550.00
Average	$101.30	$1,955.40

Devices

As nearly every student in the Northern region has access to a connected instructional device (0.97 devices per student), the average age of these devices is just over 4 years old. While this age is younger than the statewide average of 4.57 years, newer devices could help facilitate greater learning, particularly long-distance educational opportunities, for students in rural, Northern Alaska.

Case Study 13: Bering Strait District

In a district without road access, connectivity is vital for students to obtain access to a wide collection of educational content. In the Bering Strait School District, which covers approximately 77,000 square miles and consists of fifteen remote villages, the ability to bring a world of learning through technology to the largely Native Alaskan population is particularly important, yet currently a large hurdle. According to Connect Alaska's district-wide analysis, the Bering Strait District lags severely behind state averages and national benchmarks for student download speed targets.

The district is presently connected almost entirely with a satellite WAN through their ISP, creating a significant challenge in a number of areas. Issues such as uploading data to the district student information system can be difficult and creates delays for staff with everyday processes like attendance and grades. Latency with the network can also be a serious problem with a number of curriculum products and assessment tools as they have requirements that exceed the ability of the network to respond in a timely fashion.

If the district could be connected in a way that could eliminate these download, upload, and latency problems, there are a number of ways that it could immediately provide additional tools to staff and students alike. Distance learning, curriculum, and content products could assist students in driving their own education. In remote locations like this the number of courses available to the student body would increase dramatically. Also, according to the district, artistic capability in the local communities is great, but students are unable to share their art, and in some cases are being driven out of their communities, resulting in heritage and artistic cultural opportunities being lost.

With more reliable connectivity, schools would take advantage by teaching more web design classes and encouraging distance learning to ensure their students become lifelong learners.

Southwestern Region

The 8 districts in the Southwestern Region serve the smallest number of students in any region in Alaska. Like many of the other rural districts in the state, Southwestern Region schools are connected by air access only. The 38 schools represented have a Native American population of 57% with a poverty rate above the state average at 14.4%. Of the audited schools, 58% of students in this region are eligible for free or reduced lunches.

Southwestern Region schools are connected by very slow speeds, on average, around 55 Kbps per student and staff. This is only second to the Northern Region of Alaska and is coupled with very high broadband costs of $117.32 per month per student and staff (only second to the Western Region of the state). With slow speeds and high costs, broadband improvements among Southwestern schools are crucial, yet challenging, for the district served almost entirely by satellite providers. Despite these challenges, however, districts in Southwestern Alaska have the highest number of devices per student in the state – 1.06 devices per student – as schools aim to better connect students with digital learning opportunities.

Southwestern Region

- **2,315 students**
- **8 school districts:**
  - ***Aleutian Region***
  - ***Aleutians East Borough***
  - ***Bristol Bay Borough***
  - ***Dillingham City***
  - ***Lake and Peninsula Borough***
  - ***Pribilof***
  - ***Southwest Region***
  - ***Unalaska City***
- **38 schools (Audited:36)**
  - **4 Elementary**
  - **29 Middle/High**
  - **3 K-12**
  - **36 not on road system**
- **57% Native American student population**

Progress Toward Broadband Capacity Benchmarks

The average speed per student and staff in Southwestern Alaska is well below the E-rate short-term goal (100 Kbps per student and staff) and long-term goal (1000 Kbps per student and staff). Sixty-three percent (63%) of schools fall below the 100 Kbps benchmark, the highest rate in the state, and almost all (97%) of the region's schools do not meet the long-term benchmark. The chart below compares schools meeting the short-term goal to those that do not.

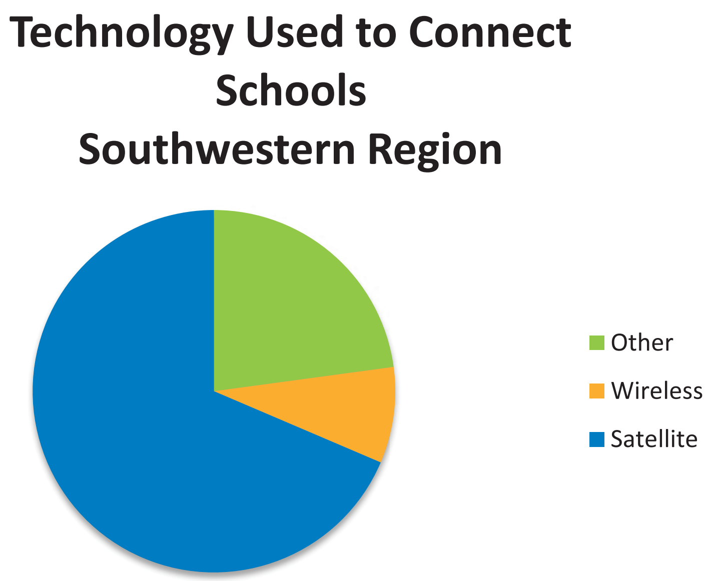
Table 27: Connectivity Comparison (Southwestern Region)

	Schools Meeting 100 Kbps/Student-Staff Target	Schools Not Meeting 100 Kbps/Student-Staff Target
Kbps/student-staff, average	178	40
Total monthly cost per Mbps	$ 1977.79	$ 2206.06
Devices/Student	1.20	1.05
Average age of devices	5	4.73

Technology Breakdown

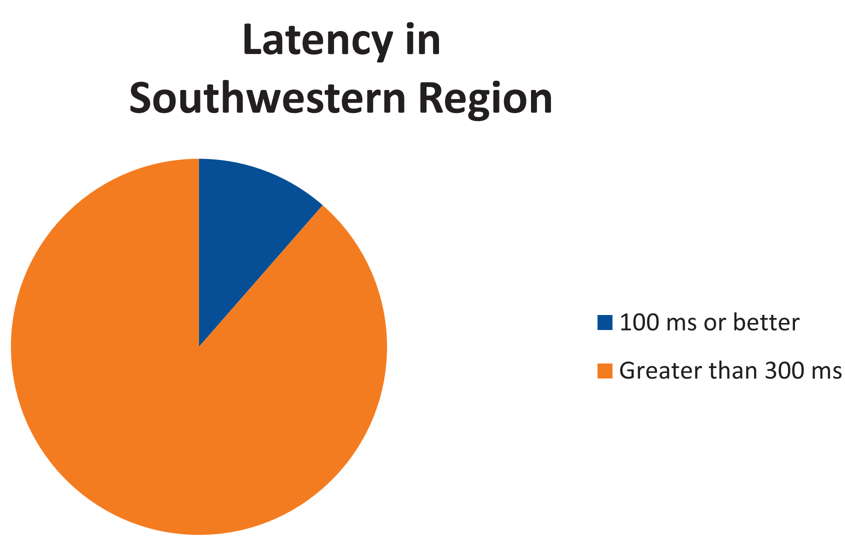
An overwhelming number of schools in the Southwestern Region are served by satellite connections – 24 out of 36 schools. There is no fiber connectivity in the area among schools with a small percentage relying on wireless and other technologies.

Figure 14: Technology Used to Connect Schools (Southwestern Region)



Latency issues also plague the Southwestern Region with the vast majority of schools (31 out of 36 schools) experiencing latency that falls greater than 300 ms. This number is not surprising given the high satellite usage, yet improved latency could result in more digital learning opportunities for students in the area.

Figure 15: Latency (Southwestern Region)



Cost

With satellite connectivity offering slower speeds and higher latency, the costs of such connectivity is also high. Schools pay, on average, $117.32 per month per student and staff, significantly higher than the statewide average of $29.79. Table 29 showcases numerous technology types in the region and the costs associated with each.

Table 28: Broadband Monthly Cost/ Student and Staff by Platform (Southwestern Region)

Platform	Monthly Cost/Student-Staff	Monthly Cost/Mbps
Satellite	$127.80	$1,951.46
Wireless	$82.16	$1,473.17
Wireline	$111.29	$3,429.77
Other	$215.13	$2,888.86
Average	**$117.32**	**$2,122.99**

Devices

As indicated in Table 16 above, the average number of devices per student in Southwestern Alaska is 1.06. This number is the highest among Alaska regions showcasing 1:1 device opportunities for students across the region. Although the number of devices is high, the average age of these devices is older than the state average. Devices in the area are on average 4.76 years old, higher than the state average of 4.57 years.

Case Study 14: Dillingham City School District

Dillingham City Schools, located off the road system in southwestern Alaska, has a world-class network that, despite limited bandwidth, has been working toward a managed structure to provide the best possible experience to students and teachers. The network supports everyday staff and student usage and has the capacity to support guests and Bring Your Own Device initiatives.

Despite the technology team's best efforts in utilizing what access to broadband it does have, the district could benefit greatly from increased bandwidth. Dillingham City Schools is currently engaged in VTC with other districts with a curriculum that maintains a significant amount of online content. Currently, only approximately three classrooms are fully utilizing the digital content; however, the school would consider widespread use of such content a great tool for learning. Additionally, remote connections for students when traveling with sports or student government would be a valuable use of increased bandwidth maximizing the contact time with instructors.

In addition to these classroom-focused opportunities, the community could also benefit from streaming for sporting events and fine arts allowing viewing for people that would otherwise be unable to attend due to the remote location.